



California ISO

# FERC Order 841 and CAISO Electric Storage Market Participation

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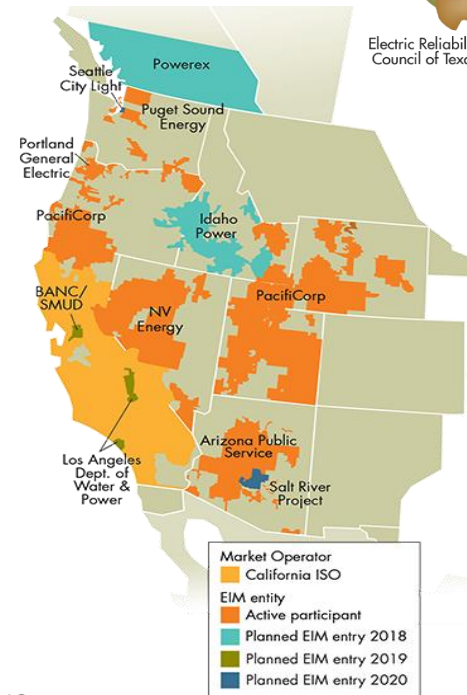
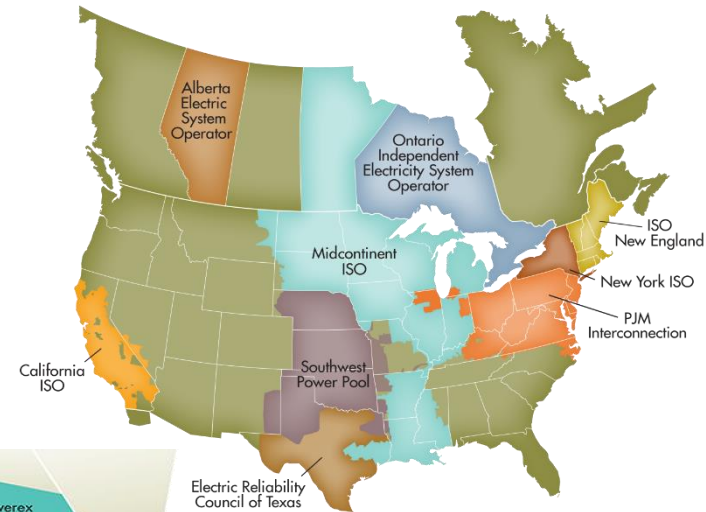
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Energy Systems Integration Group  
(ESIG) Fall Technical Workshop

CAISO PUBLIC

# The California Independent System Operator (CAISO)

- **Nonprofit** public benefit corporation
  - created by CA statute
  - regulated by the Federal Energy Regulatory Commission (FERC)
  - not a government agency
- **One of 38** balancing authorities in the western interconnection
- **50,270 MW** record peak demand (7/24/2006)
- **Serving 80%** of CA & bit of NV
- **31,000 daily** market transactions
- **\$9.3 billion** market
- **30 million** people served



# Key functions of the CAISO

- Uses advanced technology to balance supply and demand every 4 seconds
- Operate markets for wholesale electricity and reserves
  - Day Ahead
  - Fifteen Minute
  - Five Minute
- Oversees future transmission planning and new generator interconnections



Folsom, California



# California's electric power mix continues to steadily transform

- Less reliance on traditional, large-scale fossil-fueled generation
- More reliance on renewable distributed energy resources (DERs)

California energy storage mandates have emphasis on distribution and behind the meter interconnected storage

- AB 2514 (2013) - installation of 1,325 MW of energy storage by 2024
- AB 2868 (2017) - procure an additional 500 MW of distributed energy storage
- Self-Generation Incentive Program (SGIP), requires 200 MW of customer-sited energy storage to be installed by 2024

## California is Targeting:



**50%**  
renewables by  
2030



**2X**  
energy efficiency  
in existing  
buildings by 2030



**1.5M**  
electric vehicles  
by 2025



**1.325 GW**  
energy storage installed  
capacity by 2024

# FERC seeks to remove barriers to wholesale market participation by storage and DER aggregations

FERC Order No. 841 final ruling requires ISOs and RTOs to:

- Establish a storage participation model that, recognizing physical and operational characteristics of electric storage resources, accommodates their participation in organized wholesale markets
  - 12/3/2018 compliance filing, 12/2019 implementation

Deferred consideration of the following to another docket:

- Define DER aggregators as a type of market participant than can participate in the organized wholesale electric markets under the participation model that best accommodates the physical and operational characteristics of its DER aggregation
  - Technical conference held April 10, 2018

# CAISO already fundamentally complies with the Order

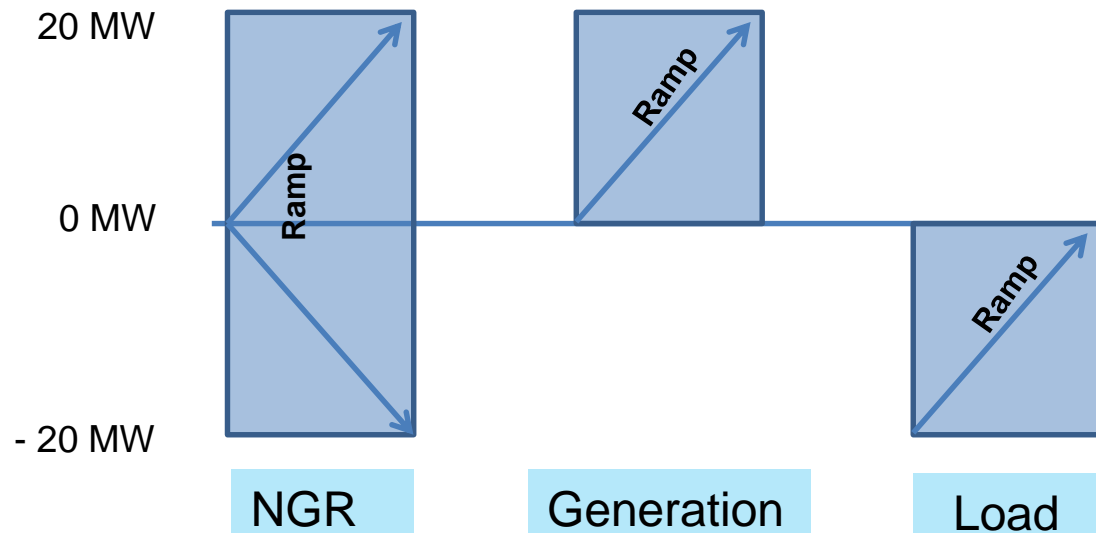
- Primary compliance lift will be lowering the minimum capacity requirement for storage resources to 100 kW
- Evaluating if current model(s) meet FERC's requirements
  - Non Generating Resource (NGR) and Pumped Storage

➤ Requested clarification/rehearing on three issues in the Order.

In 2012, the CAISO implemented a market participation model to recognize seamless operation between generation and load

### Non Generator Resource (NGR) – Transmission & Distribution

- o Designed for a resource that can vary between consuming & producing energy (e.g., storage, V2G)



# CAISO meets Orders additional new national standards

	Standard
<b>CAISO Tariff</b>	Defines an electric storage resource.
	Created a participation model for storage, and defines what characteristics meet that model.
	Made storage eligible to provide all capacity, energy, and ancillary services that it can technically provide, including services that are not procured through organized markets.
<b>CAISO Participation Model</b>	Allows storage resources to de-rate their capacity to meet minimum run-time or must-offer requirements.
	Operates a storage resource as supply and demand, and set the wholesale clearing price as either. Storage also must be allowed to self-schedule.
	Ensures that conflicting dispatch signals are not sent to storage resources by preventing supply offers and demand bids in the same interval.
	Accounts for variety of storage characteristics in resource modeling.
	Enables storage resources to manage their state of charge (SOC).
<b>CAISO Market Settlement</b>	Provides bid cost recovery/make-whole payments for storage.
	Settles storage according to the wholesale LMP.



# FERC Order required energy storage physical and operational characteristics be recognized – Yes we have these and more!

Physical or Operational Characteristic	Non-Generating Resource
State of Charge	<b>SOC in MWh</b> represents the energy in MWh that remains in the storage device. SOC is passed in 4 second telemetry and passed to the Market approximately once per minute
Maximum State of Charge	<b>Maximum Continuous Energy Limit</b> in MWh
Minimum State of Charge	<b>Minimum Continuous Energy Limit</b> in MWh (usually a value of 0 MWh)
Maximum Charge Limit	<b>Minimum Generation Capacity in MW</b> minimum capacity (negative) withdrawn from the grid when unit is charging at maximum sustainable rate. Or, minimum capacity (negative) represents the maximum load level at which it can consume energy.
Maximum Discharge Limit	<b>Maximum Generation Capacity in MW</b> maximum capacity when discharging at maximum sustainable rate Or, the maximum capacity (negative or zero) represents the lowest load level it can be reduced to.
Minimum and Maximum Charge Time	A function of SOC, bidding, and market optimization. Storage resource operators can manage the resource SOC and duration of participation through their bidding strategy and real-time participation.
Minimum and Maximum Run Time	A function of SOC, max energy MWh, and discharge rate in MW
Minimum Discharge Limit	Similar to <b>PMIN For Positive only Gen NGR</b>
Minimum Charge Limit	Similar to <b>PMIN for Dispatchable Demand Response (DDR) or Load only NGR</b>
Discharge Ramp Rate	<b>Discharge Ramp Rate</b>
Charge Ramp Rate	<b>Charge Ramp Rate</b>

## CAISO has additional NGR modeling capabilities

- Bid-in starting state of charge for Day Ahead optimization
- Upper and lower charge limits to manage MWh constraints within bids
- MasterFile Energy Efficiency parameter to reflect charge/discharge differential
- EMS telemetry includes maximum continuous energy limit which reflects max energy in MWh which can be lower than MasterFile values to reflect a real time derate

# Lessons learned from four years of energy storage participation utilizing CAISO's NGR model

## Battery Energy Storage Systems (BESSs)

- Vaca Dixon 2 MW / 14 MWh NAS battery
  - 100% dedicated to ISO wholesale market participation
- Yerba Buena 4 MW / 28 MWh NAS battery, customer R&D facility, San Jose.
  - Half energy reserved for islanding/backup for adjacent customer facility

### **Key takeaways from market participation**

Source: PG&E, "EPIC Final Report"

- CAISO day-ahead and real-time energy revenues are not currently conducive to energy arbitrage
- Frequency regulation represented the best financial use of the BESSs
- Spinning reserve revenues can very modestly add to resource revenues
- Overall, revenues from market participation seen during the project were less than those estimated by models filed with the CPUC and California Energy Commission (CEC).
- The NGR Regulation Energy Management (REM) Model is effective in managing BESS State of Charge (SOC) and simplifying operations.

# A Multi-Use Application Framework for Storage was adopted by the California Public Utility Commission

## Commission Decision (D.18-01-003) – issued 1/11/2018

- Adopted identified domains, services and 11 rules
- Deferred open issues to working group
- 2018 Working Group completed submission of report addressing issues
  - Utility and industry differ on approach to resolving issues

Table 1. Domains: Reliability Services and Non-Reliability Services

Domain	Reliability Services	Non-Reliability Services
Customer	None	TOU bill management; Demand charge management; Increased self-consumption of on-site generation; Back-up power; Supporting customer participation in DR programs
Distribution <sup>7</sup>	Distribution capacity deferral; Reliability (back-tie) services; Voltage support; Resiliency/microgrid/islanding	None
Transmission	Transmission deferral; Inertia*; Primary frequency response*; Voltage support*; Black start	None
Wholesale Market	Frequency regulation; Spinning reserves; Non-spinning reserves; Flexible ramping product	Energy
Resource Adequacy	Local capacity; Flexible capacity; System capacity	None

\*Voltage support, inertia, and primary frequency response have traditionally been obtained as inherent characteristics of conventional generators, and are not today procured as distinct services. We include them here as placeholders for services that could be defined and procured in the future by the CAISO.

# CAISO has additional models available for energy storage participation in its markets

- Proxy Demand Resource, 2010 (PDR) – Distribution
  - Supplier can aggregate multiple end-use customers to create a virtual supply resource
  - May involve other DER types behind customer meter, but will not be settled in market for net energy injection to the system (load offset only)
- DER Provider, 2016 (DERP) - Distribution
  - Create a pathway for DERs to be aggregated and meet .5 MW minimum participation requirement
  - Allows aggregations from resources in front of and behind the end-use customer meter

# Final Thoughts

- Energy storage is unique in how many services it can provide
  - Multi-use application rules must be in place, participation models developed, and markets changed to realize full benefit
- It can play a role in solving the duck curve – how significant?
- The *status quo* needs to change without unduly benefiting storage (and unduly disadvantaging other resources)
- Adjusting regulations to allow storage to provide multiple services may be easier than actually providing multiple services.
  - Can a battery provide its output for resource adequacy more than 4 hours, 6 hours, 8 hours?

# THANK YOU

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